

**NASA Public Health Program Review,
Savannah, GA, September 2009**

NASA-CAN-DS

**Enhancing Malaria Early Warning Systems (MEWS) with
NASA earth science, observation and modeling results**

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International Research Institute for Climate & Society (IRI),
The Earth Institute at Columbia University, New York



Outline

- 
- ❑ **The IRI**
 - ❑ **The project life cycle....**
 - ❑ **The Current Context ...**
 - ❑ **The DSS**
 - ❑ **Application**
 - ❑ **Research**
 - ❑ **Results/Evidence**
 - ❑ **Outputs/Dissemination.**
 - ❑ **So what next?**



How can we get the knowledge benefit from recent advances in climate science and observation

...into climate sensitive development sectors...

...to more effectively manage the associated risks affecting vulnerable populations?

EWS ~> CRM ~> CCA





The project life cycle.....

A 'three year' project

.....a grey period >12 months.....

- Began Sept 2006
- Due to end Aug 2009
- No-cost extension until end of 2009



Current Context

..... high Climate-Health profile:

- ❑ **2007 IPCC 4th Assessment Report**
- ❑ **2008 WHD & Special Resolution 61st WHA**
- ❑ **2009 World Climate Conference (WCC3)**
- ❑ **2009 GEO H&E (2)**
- ❑ **~> 2009 COP-15/MOP-5 (UNFCCC-Negotiations)**

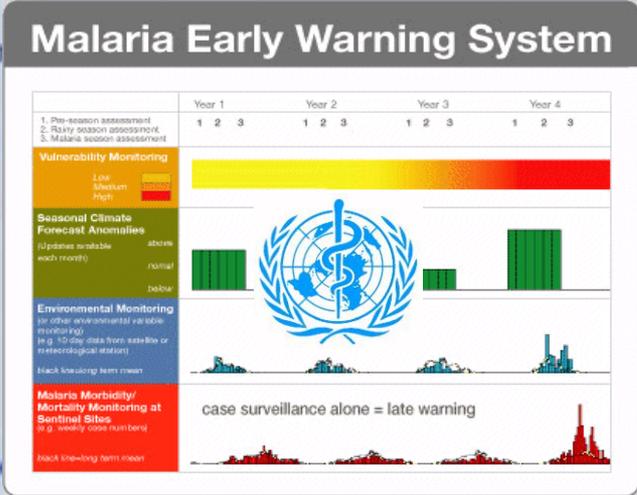
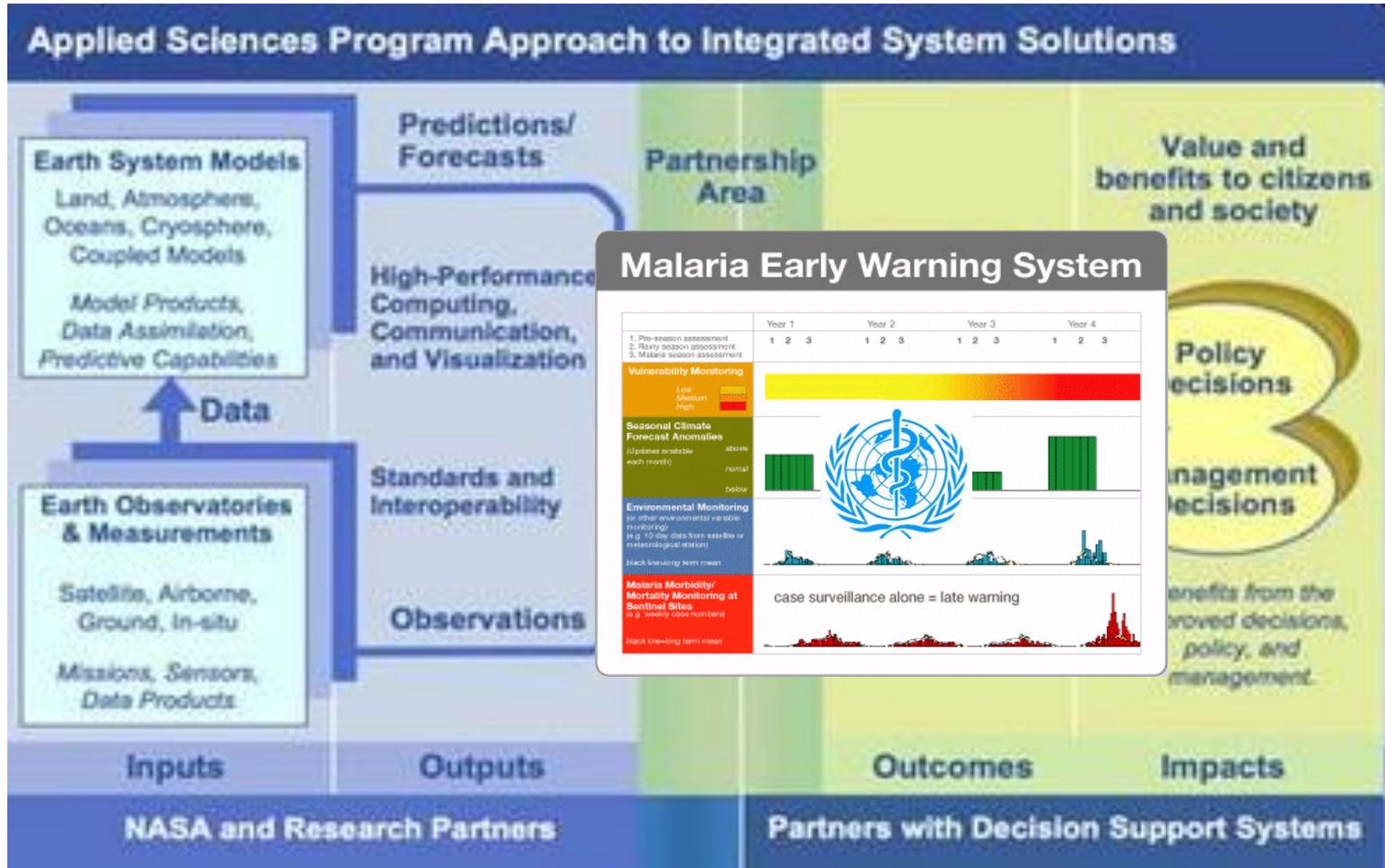
Context - Climate and Health.....

Climate may impact on health through a number of mechanisms

- directly through major storms, cold or heat stress – aggravating conditions such as heart and respiratory disease,
- and indirectly, for example through:
 - a) drought-food security (nutrition/immuno-suppression)
 - b) water source quality and water-borne disease
 - c) infectious disease

These last 3 issues implicated in an estimated 10-15 million child deaths per year in Africa alone..... MDGs, etc.....

The DSS.....



Climate and Health

Using Climate to Predict Infectious Disease Epidemics.

Diseases include:

Influenza

Meningitis

Leishmaniasis

R.V. Fever

Cholera

Malaria

Dengue

Inter-annual variability:

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Sensitivity to climate#:

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Climate variables:

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(>T,>R)

>R (<T)

(>T)

(>R,T,H)

(>R,T,H)

Using climate to predict infectious disease epidemics



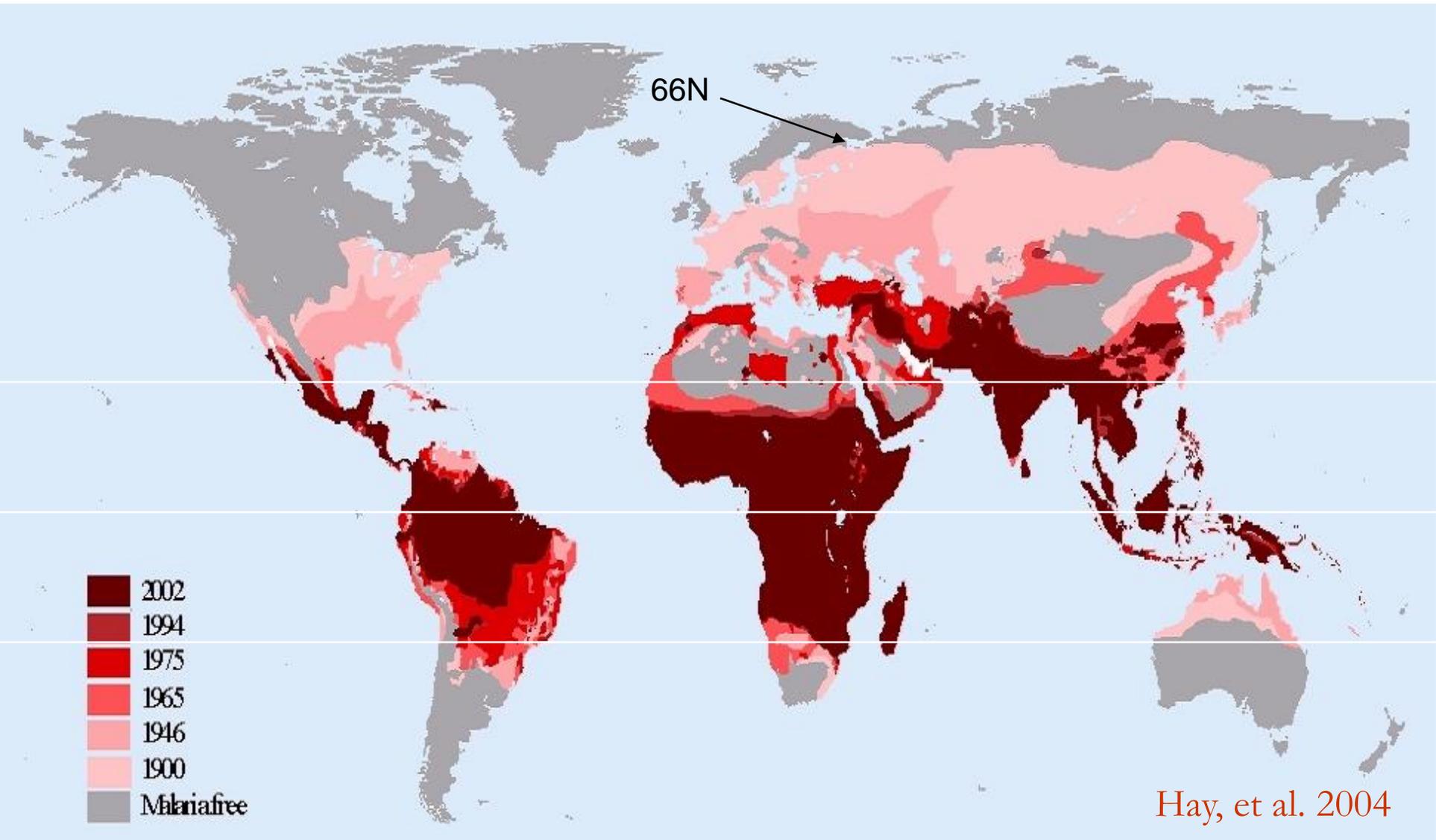
Geneva 2005

.. bacterial, viral and protozoan ..

..other candidates, e.g some respiratory and pulmonary diseases, allergies, cancers, etc. not yet included....

... must remember socio economic factors very important...

Distribution of malaria (a Tropical Disease ?)



Where malaria is not adequately controlled – climate largely determines the seasonal endemicity and epidemicity of malaria

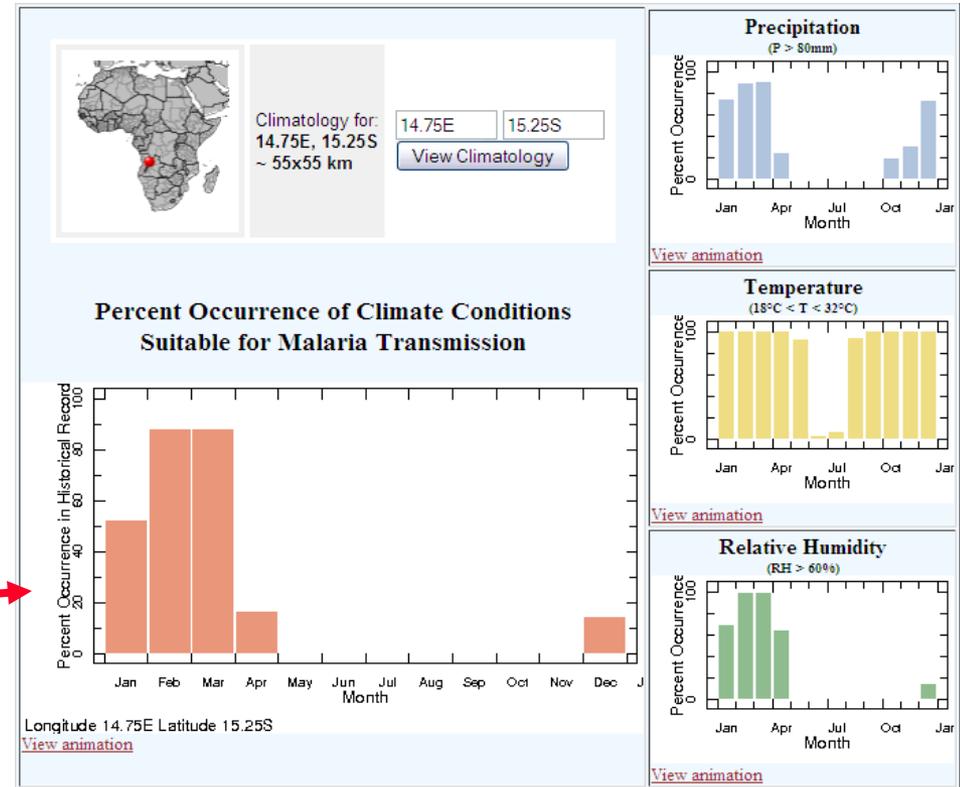
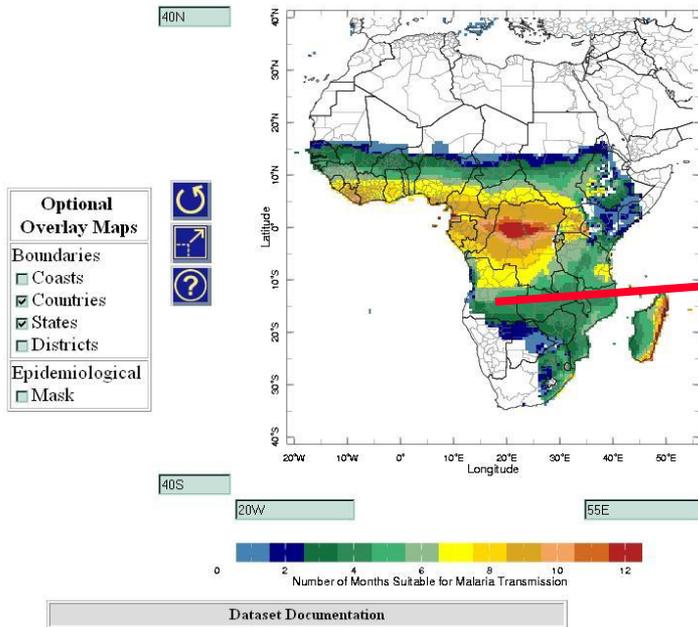
Climate and endemic malaria

Due to poor epidemiological data in sub-Saharan Africa – climate/env. data often used to help model and map the distribution of disease.

[e.g. on IRI website](#)

Climate suitability for endemic malaria

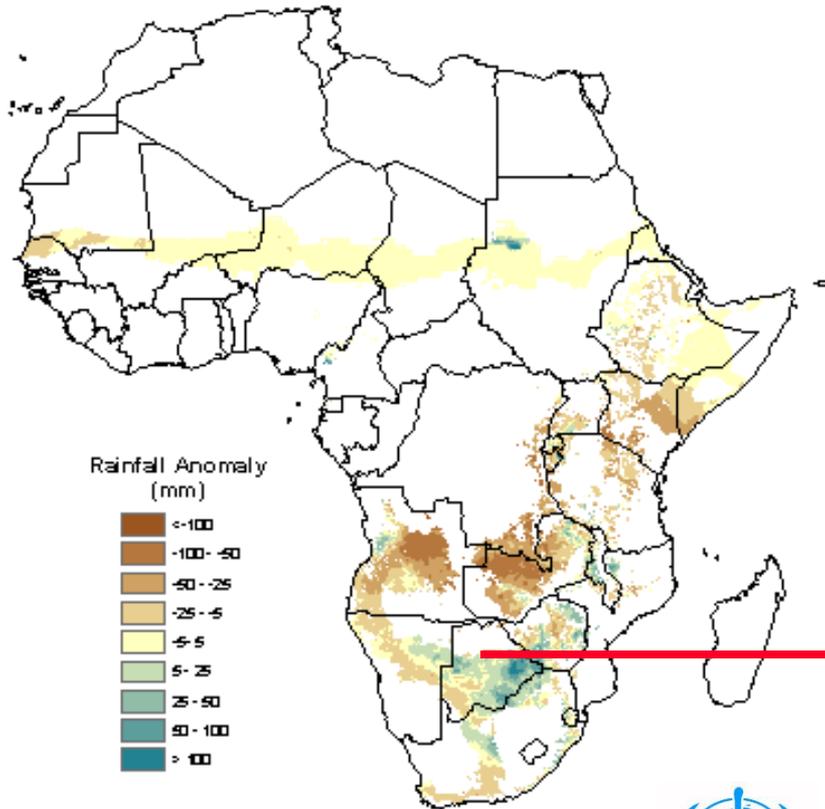
= 18-32°C + 80mm + RH>60%



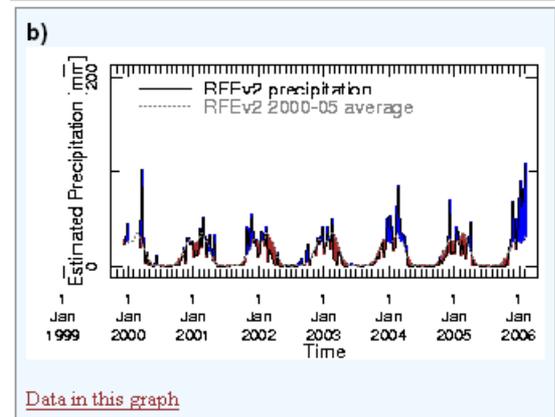
Based on long-term averages - information relevant to seasonal control calendars....

Climate and epidemic malaria

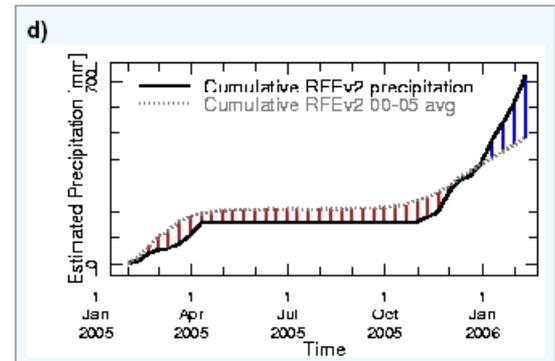
Rainfall Anomalies
in
Zones with Malaria Epidemic Potential
January 1 - 10, 2009



Rainfall anomalies...useful information
for desert fringe epidemic malaria ... e.g.
Botswana

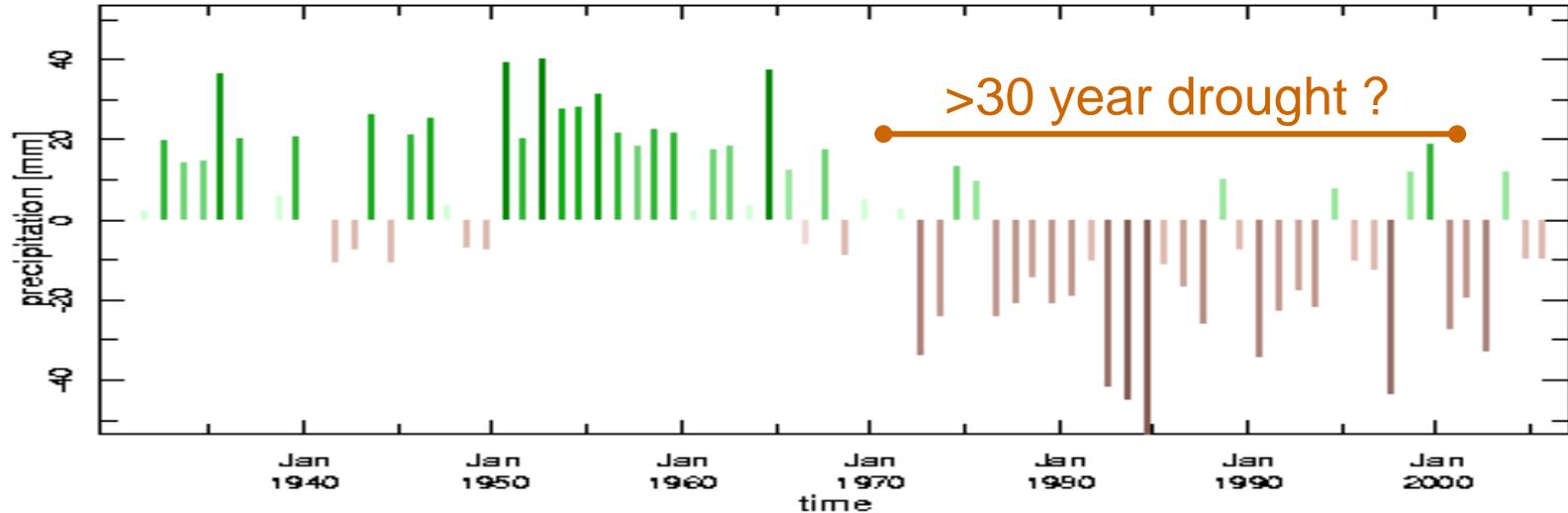


Link to IRI
website



Impact of climate trends....

..or long-term anomalies (e.g. Sahelian rainfall 1930-2007)

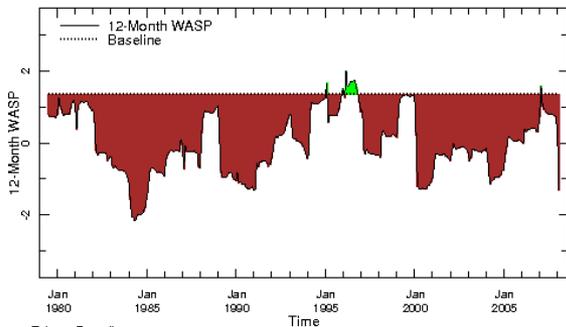


Changes in malaria

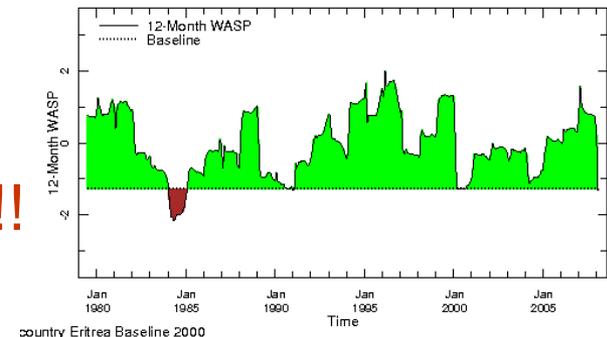
- <endemicity (Faye et al 1995)
- >epidemicity (Mouchet et al 1996)

Changes in meningitis

- >endemicity (Molesworth et al 2003)
- >extension of 'Meningitis Belt'

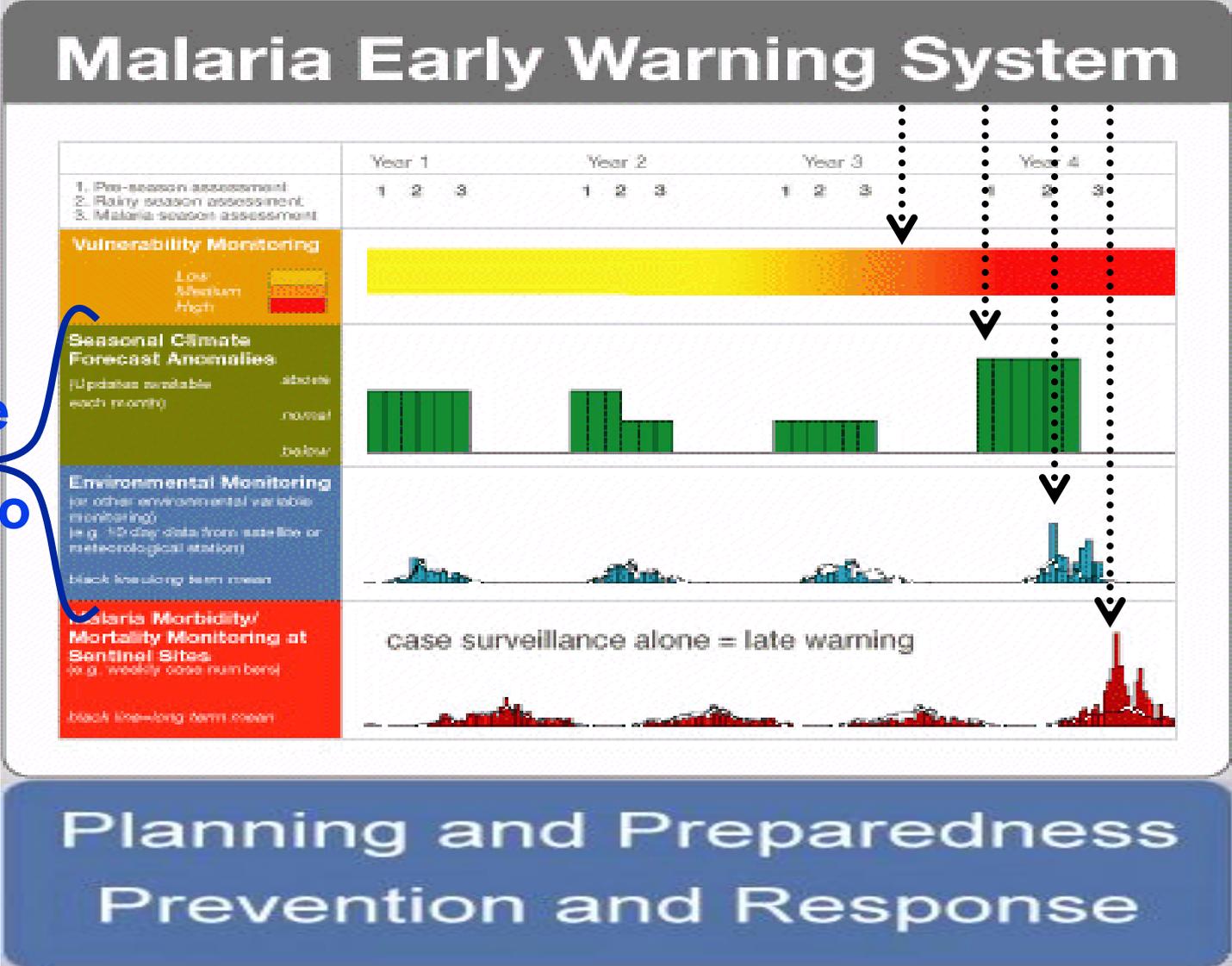


!! Very important consideration when establishing baselines !!
[tool on IRI website](#)



Demand for integrated early warning systems ...

Integrated MEWS gathering cumulative evidence for early and focused epidemic preparedness and response



Climate
Env-Info

Planning and Preparedness
Prevention and Response

Demands for evidence-based health policy

Before using climate information in routine decision making health policy advisors need:

Evidence of the impact of climate variability on their specific outcome of interest, and

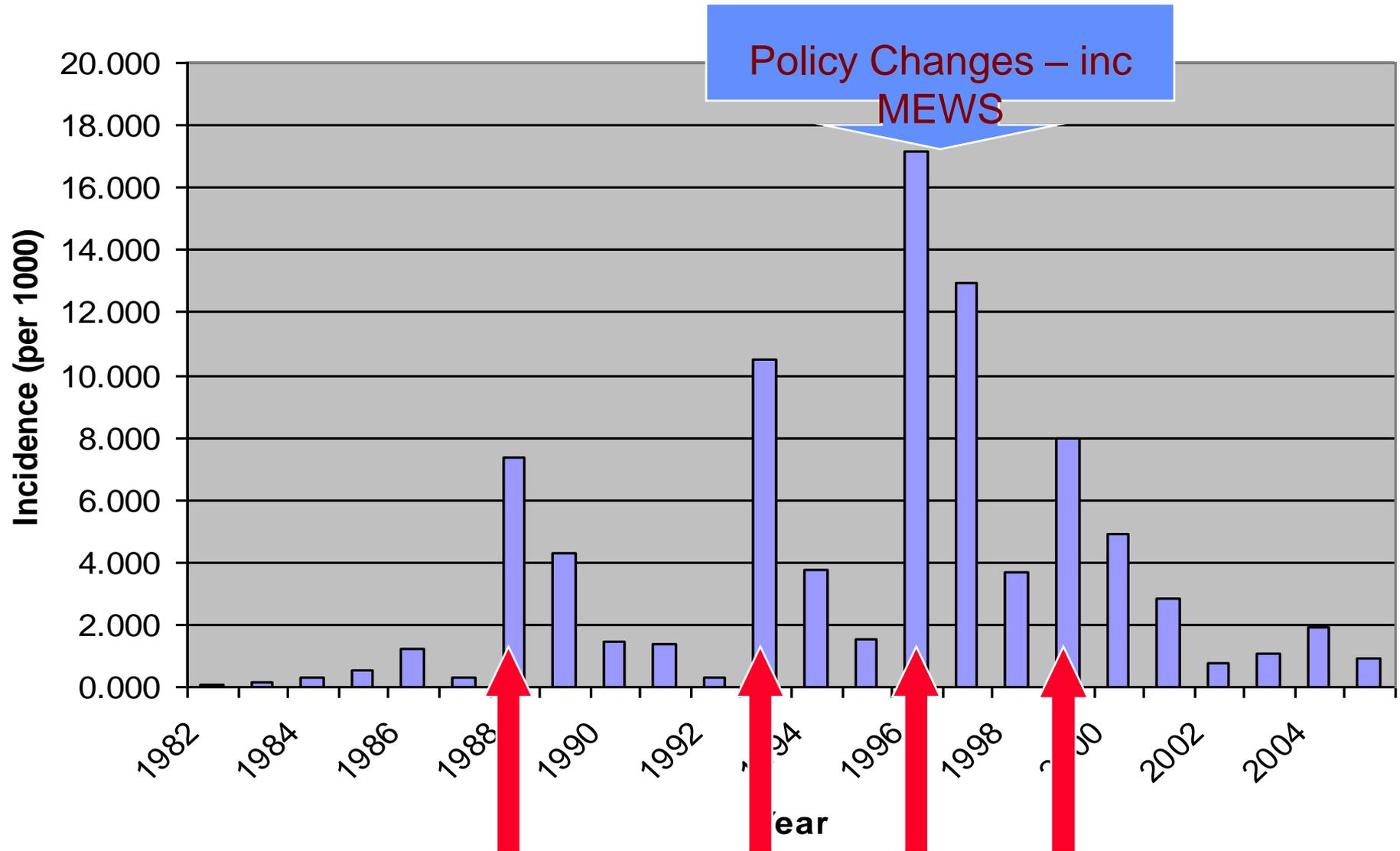
Evidence that the information can be practically useful within their decision frameworks, and

Evidence that using climate information is a cost-effective means to improving health outcomes.

.....a case study >>>>>

MEWS in Botswana....

Malaria incidence



Vulnerability monitoring

Vulnerability

Low
Medium
High



Example in practice: Botswana ...

Routine assessment of drug efficacy in sentinel sites, susceptibility of the vector to insecticides, coverage of IRS achieved each season

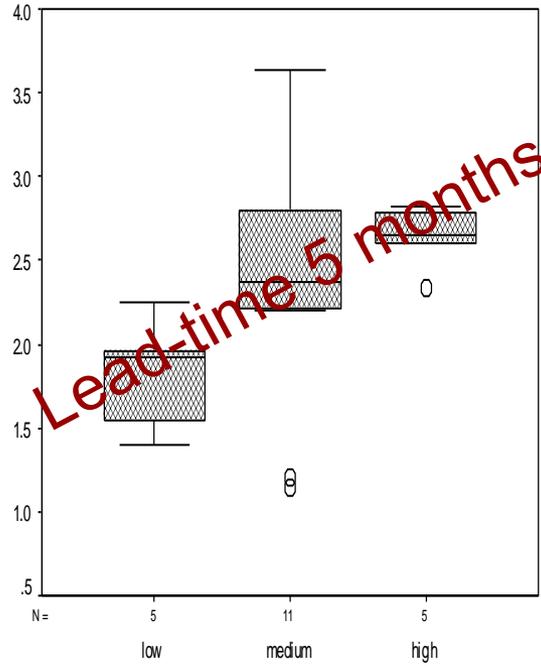
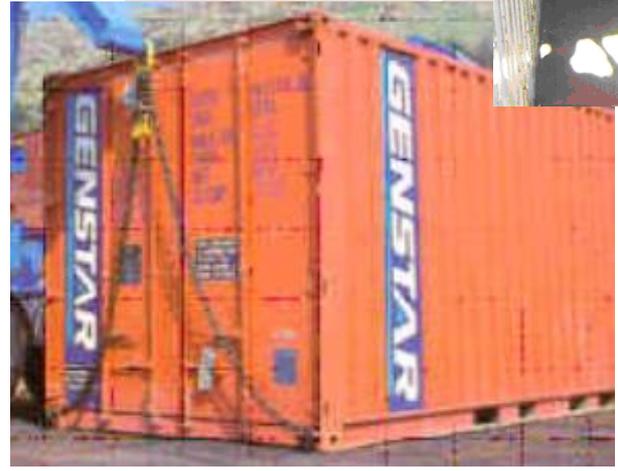
Regular assessment of drought-food security status from SADC Drought Monitoring Centre - disseminates the information to the epidemic prone DHTs

Recognises need for extra vigilance among its most vulnerable groups, including those co-infected with HIV, TB, etc.

Seasonal Climate Forecasting



Example in Botswana SCF offers good opportunities for planning and preparedness. NMCP strengthens vector control measures and prepares emergency containers with mobile treatment centres



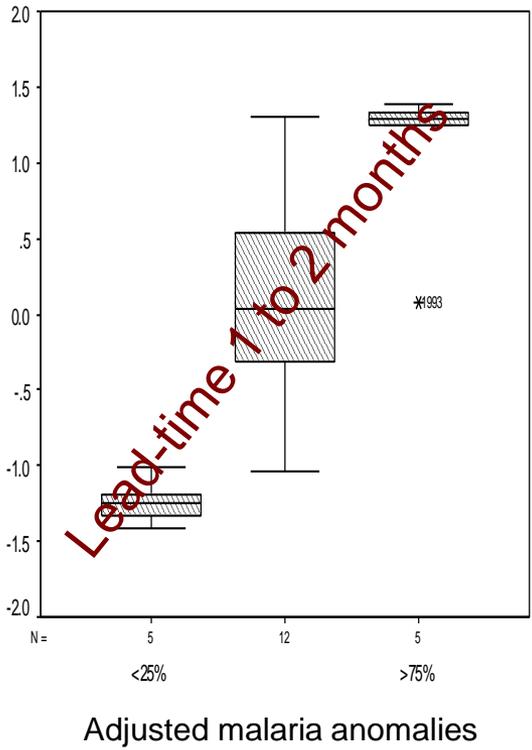
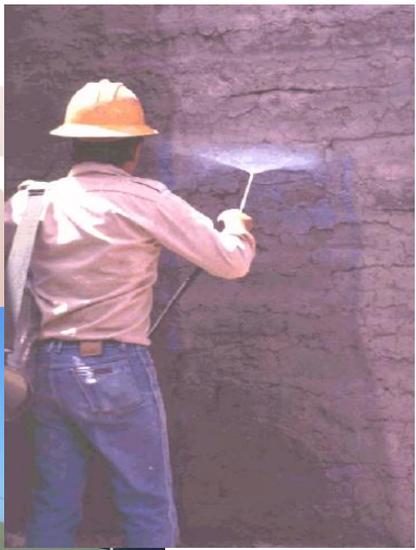
Evidence of impact of climate variability on specific outcome of interest (Thomson, et al. *Nature*. 2006)

Adjusted malaria anomalies

Environmental monitoring

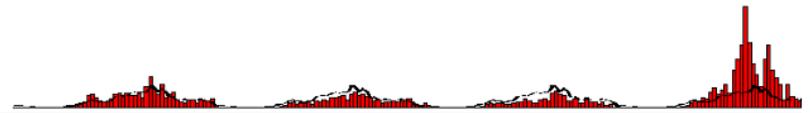


Example in Botswana ... ENV monitoring enables opportunities to focus and mobilise more localised response, i.e. vector control and location of emergency treatment centres....



Evidence of impact of climate variability on specific outcome of interest (Thomson, et al. *AJTMH*. 2005)

Case surveillance



Example in Botswana .. Of a number of indicators (WHO 2004) the NMCP uses case thresholds defined for three levels of alert ...

OKAVANGO SUB-DISTRICT

ACTION 1: When district notification reaches/exceeds 600 unconfirmed cases/week

DEPLOY EXTRA MANPOWER AS PER NATIONAL PLAN

- ◆ Request 4 nurses from ULGS by telephone/fax
- ◆ Collect the 4 nurses from districts directed by ULGS
- ◆ Erect tents where needed
- ◆ Catchment areas to deploy volunteers in hard-to-reach areas
- ◆ Print bi-weekly newsletter to inform community about epidemic

Threshold 1- 600 unconfirmed cases/week >>> Action Plan 1.

ACTION 2: When district notification reaches/exceeds 800 unconfirmed cases/week

DEPLOY MOBILE TEAMS PER DISTRICT PLAN

- a) Each team to be up of a Nurse or FEW, a vehicle and a driver
- b) Deploy teams as follows:

TEAM AND DEPLOYMENT AREA	VEHICLE	Reg No
Team A: Qangwa area	Council	
Team B: Habu/ Tubu / Nxaunxau area	Council	
Team C: Chukumuchu / Tsodilo / Nxaunxau area	Council	
Team D: Shakawe clinic (vehicle and driver only)	DHT vehicle	
Team E: Gani / Xaudum area	Gani HP vehicle	
Team F: Mogocho / Tobera / Kaputura / Ngarange area	Mogocho HP vehicle	
Team G: Seronga to Gudigwa area	Gudigwa HP vehicle	
Team H: Seronga to Jao Flats	Boat	

Threshold 2- 1000 unconfirmed cases/week >>> Action Plan 2.

- c) Deploy MO at Shakawe and 2 more nurses as per National Manpower contingency plan

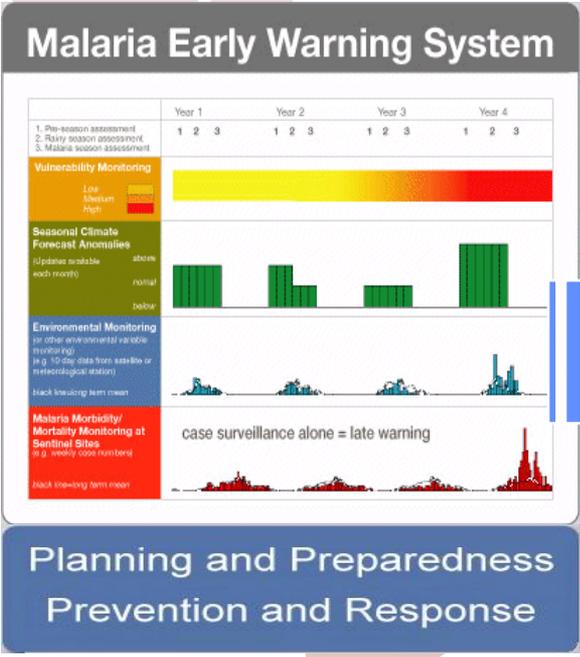
ACTION 3: When district notification reaches/exceeds 3000 unconfirmed cases/week

DECLARE DISTRICT DISASTER

- a) Call for more outside help (manpower, vehicles, tents, etc)
- b) Convert some mobile stops to static treatment centres
- c) Station nurses at the static treatment centres
- d) Station GDA to assist nurse eg cooking for patients on observation
- e) Erect tents with beds and mattresses (6 – 10 beds/tents) at selected centres
- f) Station vehicles at selected centres
- g) Deploy MO or FNP at Seronga
- h) Station officer from MOH to co-ordinate epidemic control with DHSC

Threshold 3- 3000 unconfirmed cases/week >>> Action Plan 3.

Southern African Regional Pre-Season Epidemic Malaria Outlook Forum, Harare, 2004, onwards (extending to GHA >2007)



Evidence of operational utility (DaSilva, et al. MJ 2004 & TinP 2007)
 Evidence of timing/cost-effectiveness (Worrall, et al. TMIH 2007 & MJ 2008)

Malaria Surveillance, Forecasting, Preparedness and Response in Southern Africa

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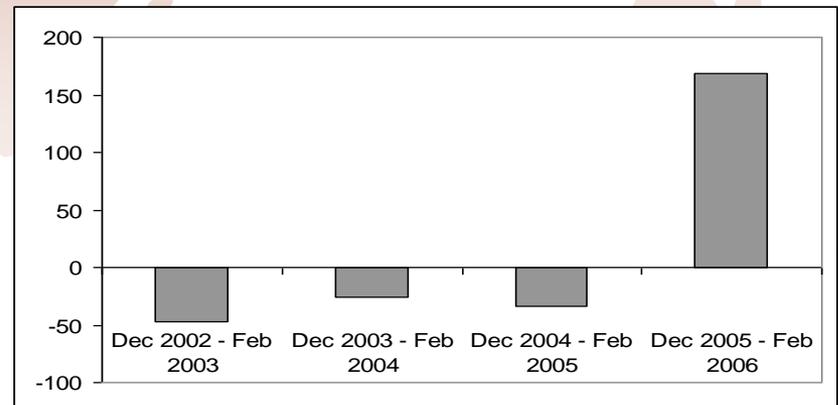
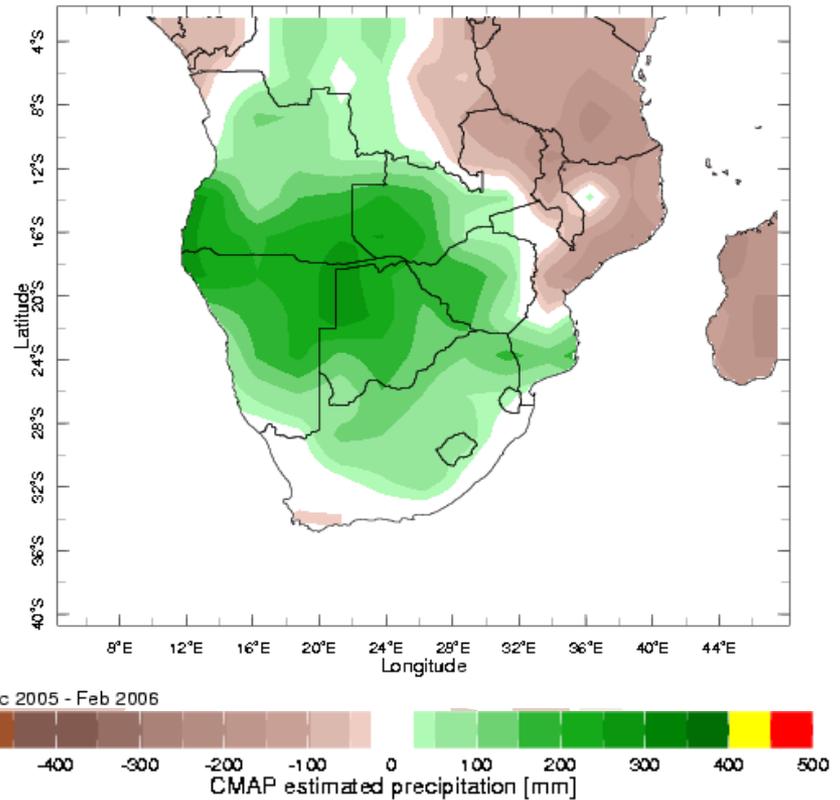
References
 Beale, H. et al. (2004). "Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease: Part 1: determinants operating at individual and household level." The Lancet May 4: 267-271.
 Bawa, L. et al. (2004). "Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease: Part 2: determinants operating at environmental and institutional level." The Lancet June 6: 368-375.
 DaSilva, J. et al. (2004). "Improving epidemic malaria planning, preparedness and response in Southern Africa." Malaria Journal (October 2004) 3: 368-375.
 Goddard, L. et al. (2001). "Current approaches to seasonal to interannual climate prediction." International Journal of Climatology 21: 1111-1152.
 Hobbs, J.A. et al. (1998). Malaria epidemiology, detection and control: forecasting and prevention. WHO/MAL/98.1084.
 SADC (2003). SADC Malaria Report 2003. Gaborone, Southern Africa Development Community.
 Thompson, M.C. and S.L. Corcoran (2001). "The development of malaria early warning systems for Africa." Trends in Parasitology 17(8): 438-445.
 WHO (2001). Malaria Early Warning Systems: concepts, indicators and partners. A framework for field research in Africa. Geneva, WHO/WHOCCS/MSM/2001.38.
 WHO (2004). Malaria epidemiology, forecasting, prevention, early warning and control: From policy to practice. Geneva, World Health Organisation: 59.

The 2005/06 season in Southern Africa.....

A 'test case' for MEWS in the Southern Africa region

A 'wet year' following three 'drought' years (like 96/97) when major regional epidemics occurred

“Classic post-drought epidemics” have occurred periodically in Southern Africa’s history



Demonstrated progress.....

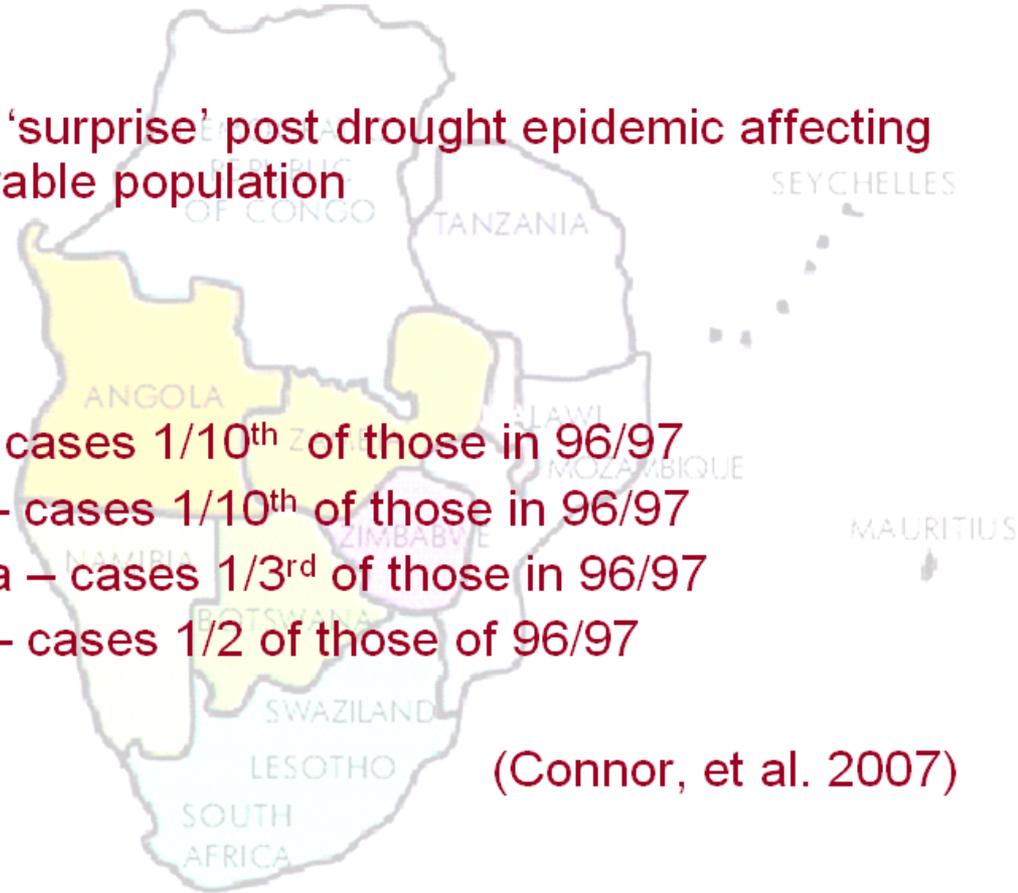
The 2005/2006 season in Southern Africa.....

Potential for a 'surprise' post drought epidemic affecting
large vulnerable population

But in fact:

- ◆ Botswana - cases 1/10th of those in 96/97
- ◆ Swaziland – cases 1/10th of those in 96/97
- ◆ South Africa – cases 1/3rd of those in 96/97
- ◆ Zimbabwe – cases 1/2 of those of 96/97

(Connor, et al. 2007)

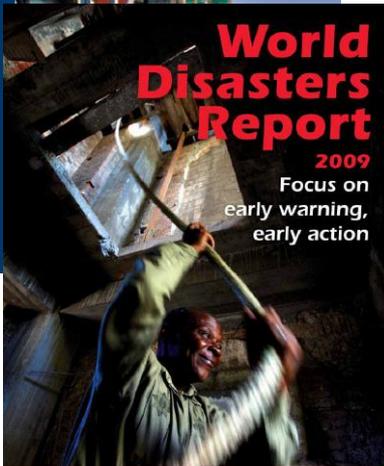


Climate information for
adaptation and
development needs

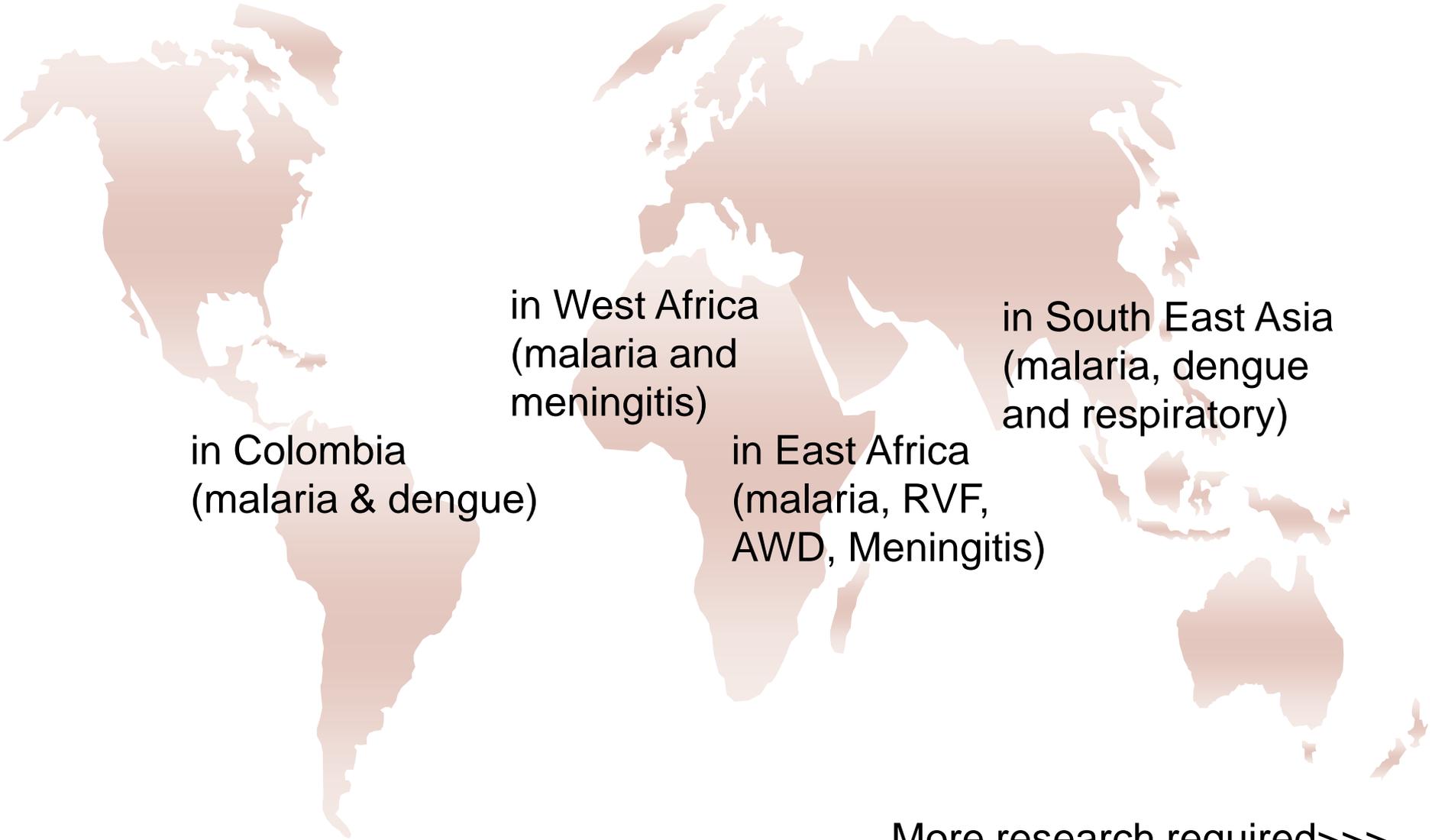


World Disasters Report 2009

Focus on
early warning,
early action



And for application of the approach elsewhere ?



in Colombia
(malaria & dengue)

in West Africa
(malaria and
meningitis)

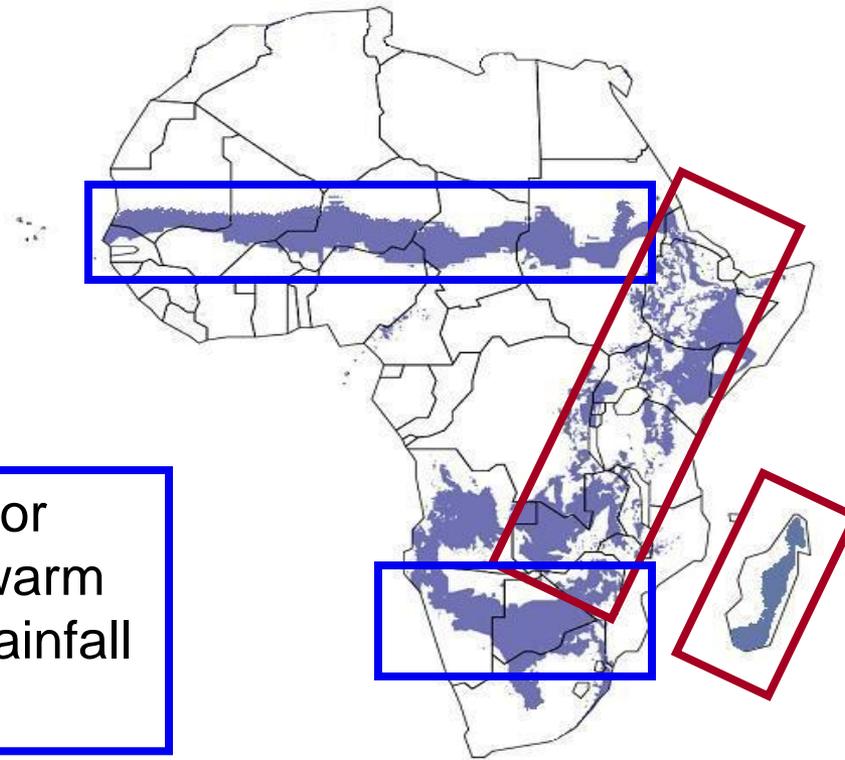
in East Africa
(malaria, RVF,
AWD, Meningitis)

in South East Asia
(malaria, dengue
and respiratory)

More research required>>>

Importance of temperature monitoring.....

Areas at risk of epidemic malaria



In the warm or seasonally warm lowlands – rainfall is critical

In the highlands both rainfall & temperature are critical factors....

Densely populated and epidemic prone

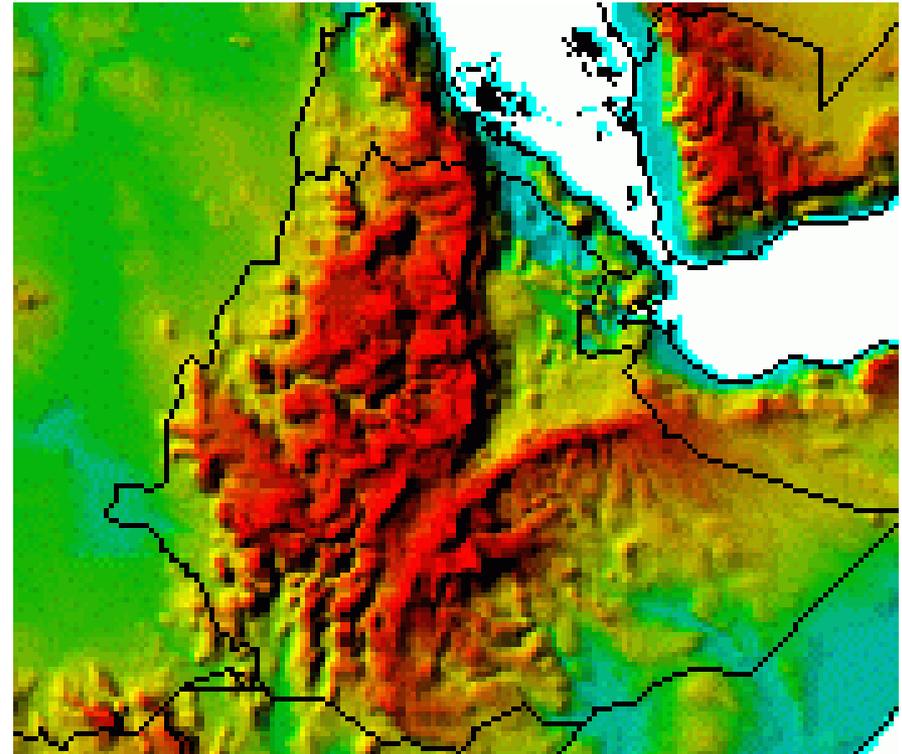
Ethiopian highland region a major challengelargest epidemic prone population in Africa

Validation of 12 Satellite derived Rainfall Estimate Products against ground measurements (147 stations)

Huge variation in accuracy of products

(though Ethiopia is perhaps a 'worse case scenario')

1. **Low resolution(10-day @ 1deg, and monthly @2.5deg)**
(Dinku et al., 2007: Int J Rem Sens)
2. **Hi resolution (daily @ 0.25-deg)**
(Dinku et al., 2007: Int J Rem Sens)
3. **Gridded climatology products**
(Dinku et al., 2008: Int J Climatology)

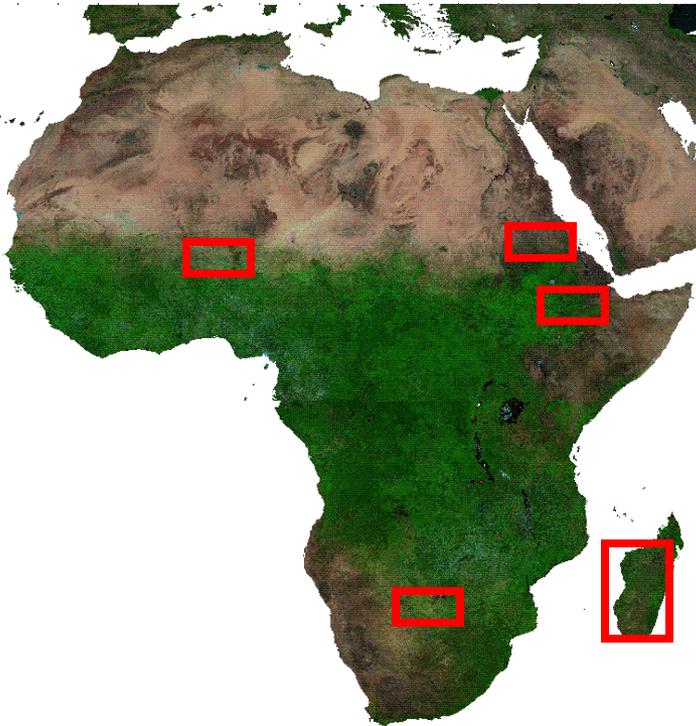


But what about temperature?

Temperature estimate study

Daily station data

Land Surface Temperatures and modeled temperature derived from:

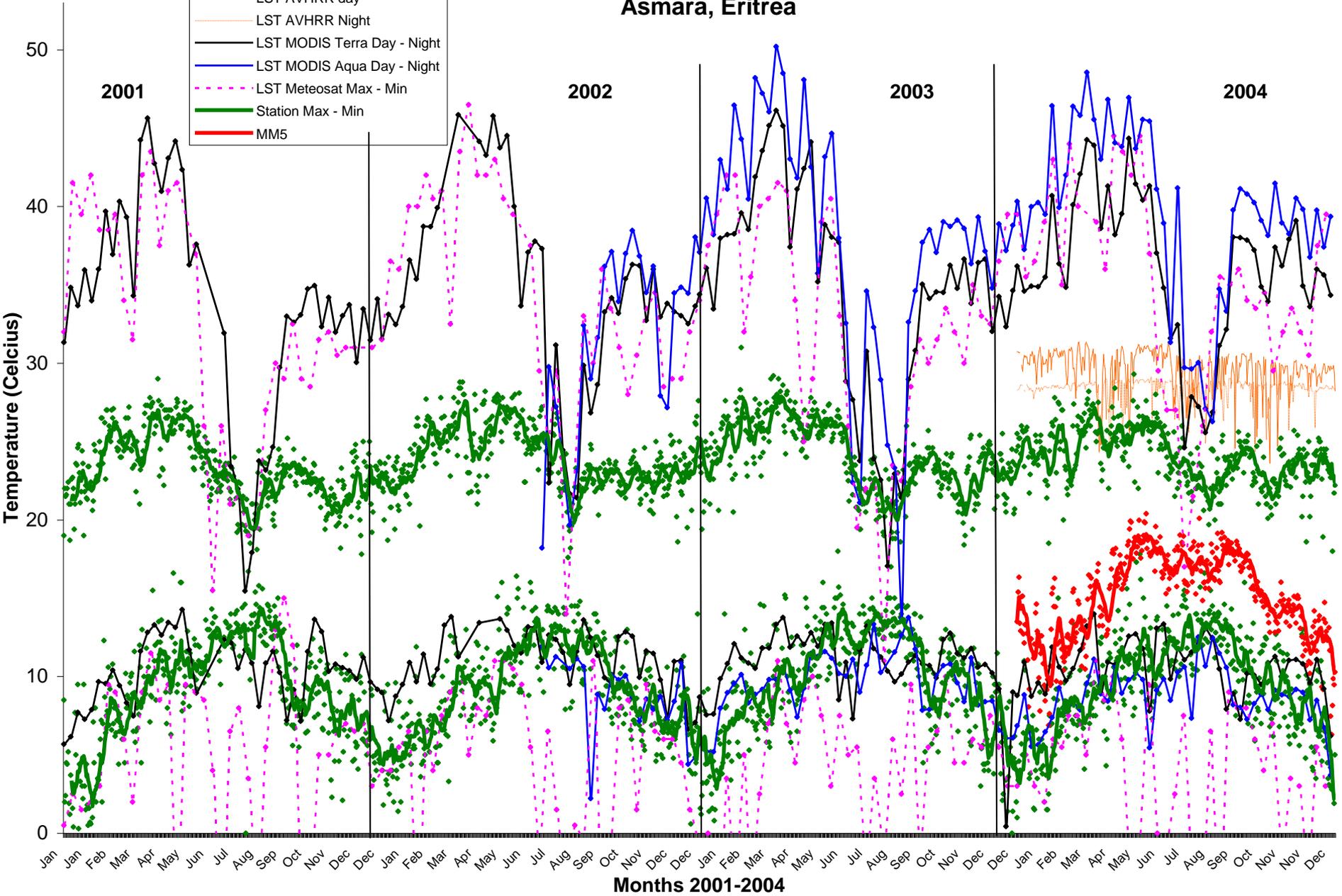


- LST AVHRR: Day – Night (daily) 1995-2000
- LST MODIS TERRA: Day – Night (daily and 8-day composite) 2000-2008
- LST MODIS AQUA: Day – Night (daily and 8-day composite) 2002-2008
- LST METEOSAT: Day – Night (10-day composite) 1995-2005
- MM5: (Daily) 2004-2006
- GFS, GDAS, NCEP reanalysis

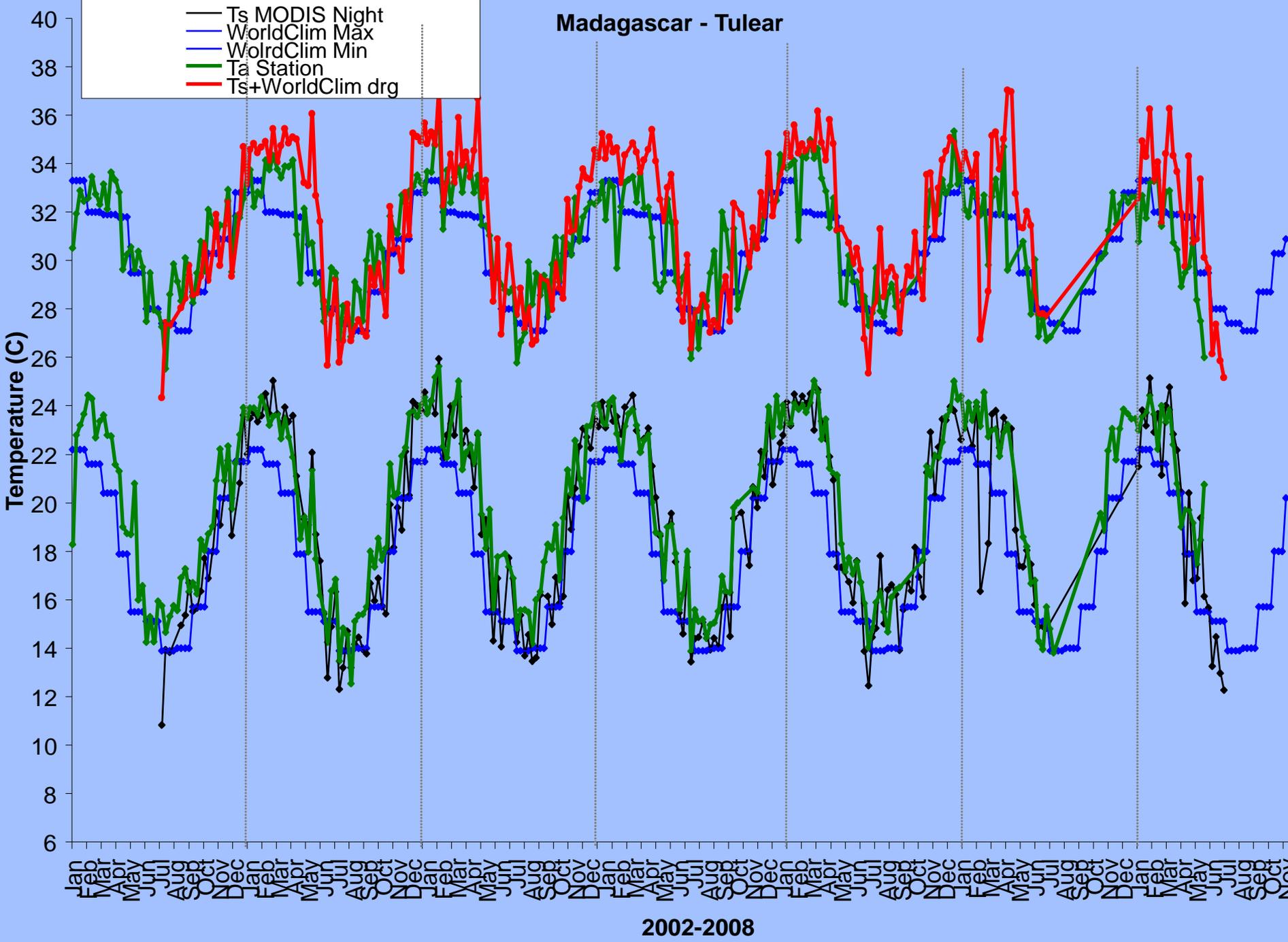
Temperature estimation.....

Asmara, Eritrea

- LST AVHRR day
- LST AVHRR Night
- LST MODIS Terra Day - Night
- LST MODIS Aqua Day - Night
- LST Meteosat Max - Min
- Station Max - Min
- MM5

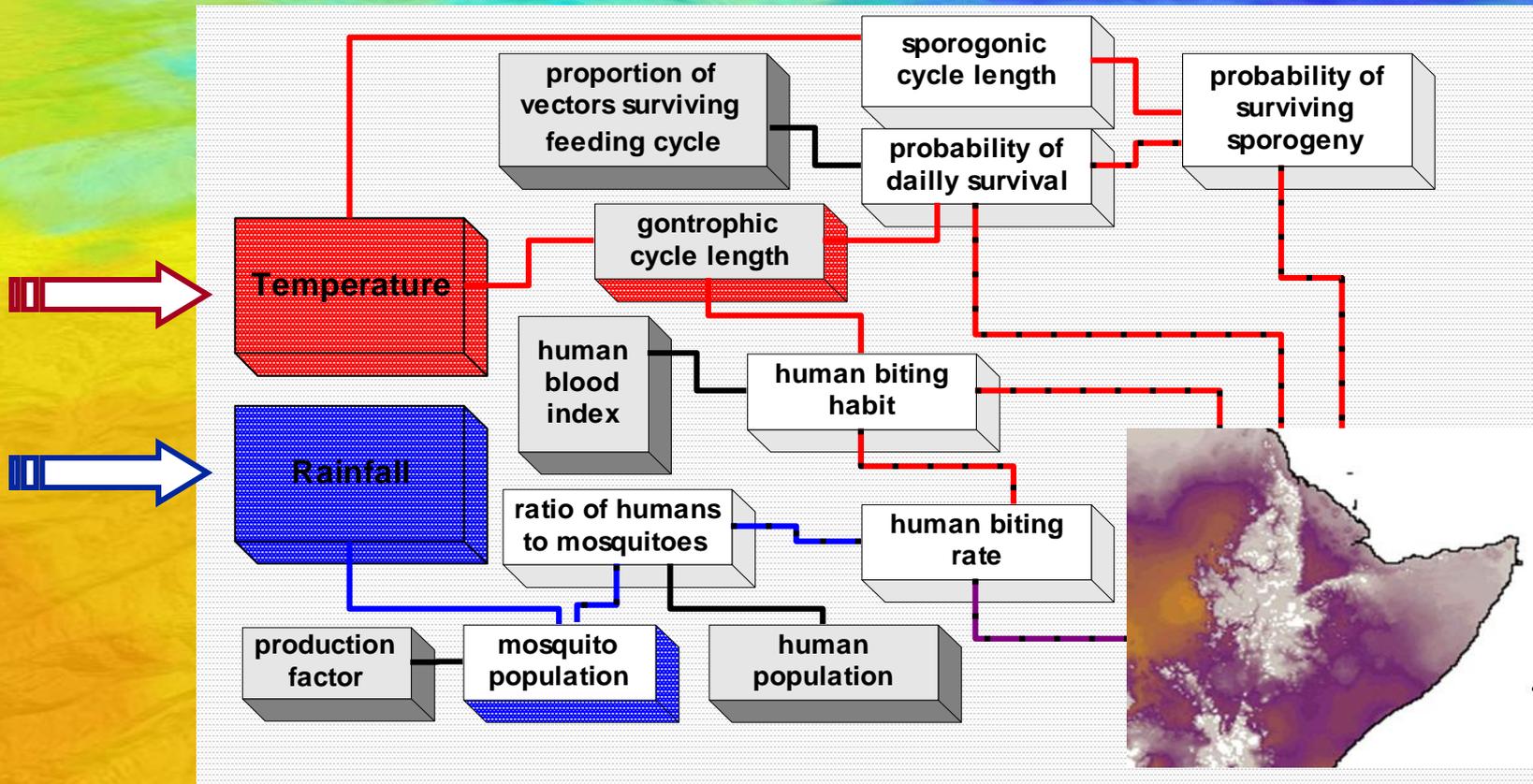


Madagascar - Tulear



2002-2008

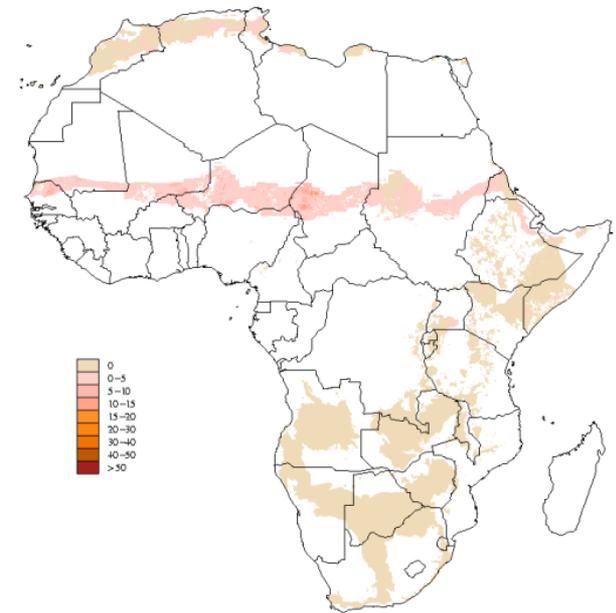
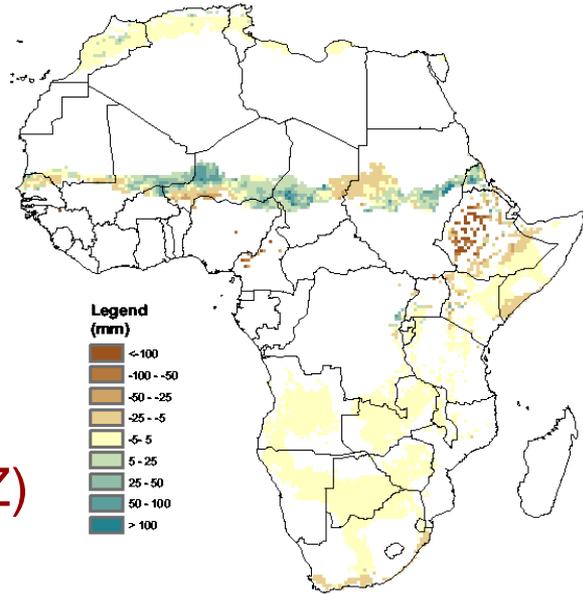
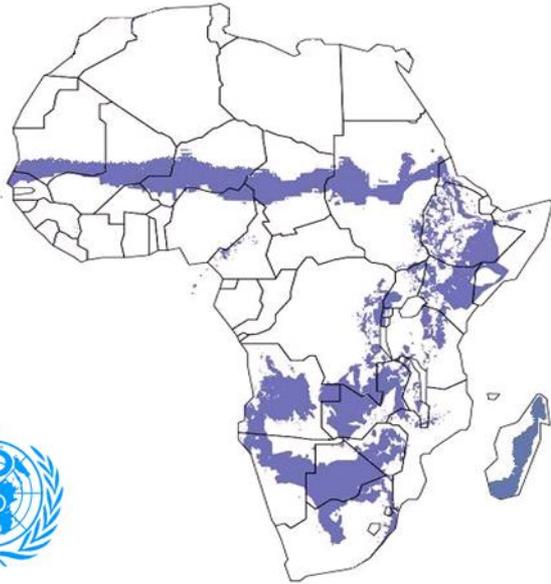
Malaria: Vectoral Capacity $V = ma^2P^n / -lnP$ (after Garrett-Jones 1964)



10 Daily VCAP product....

this project produce operational 10 daily VCAP through FEWS-NET website

...with additional resources on IRI website



Epidemic Risk Zones (ERZ)

~> RFE anomalies in ERZ

~> Vectoral capacity in ERZ

FEWS



Africa Data Dissemination Service

Home

FEWS Net Partners

Publications/Related Links

Help

Site Search

Outputs

- 
- ❑ Publications (~10 peer review - research focus)
 - ❑ Reports (>25 related publications – inc. book chapters)
 - ❑ Presentations (>30 inc US, Int: Africa, Asia, Latin America, Europe)
 - ❑ Follow on funding (e.g. Google.org project)
 - ❑ Trained individuals (cross disciplinary)

So what? – What's next?

Opportunities - high C-H profile – EWS – CRM – CCA

Major investments in Malaria Control e.g. PMI, GFATM (>1 US\$ Billion p.a.)

new (Gates) interest in move towards malaria elimination in selected regions

..will require much smarter – more broadly informed – surveillance systems..

..recent WMO-WHO-IRI-HCF Session and Workshop at WCC3 in Geneva...

Follow on projects – e.g. Google.org project for Ethiopia/East Africa:

- ❑ *“Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa”*

Establish Multi-Agency Climate-Health Working Group

Objectives of the Working Group

To create awareness on the impact of weather and climate on health

To develop effective and functional means for the health sectors and beneficiary communities to routinely use appropriate climate information for estimating populations at risk of climate sensitive diseases (where and when – including early warning systems)

To stimulate the partners in the climate/environment community to identify needs, create relevant products and supply appropriate services.



Members and Establishment of the Working Group

1. Federal Ministry of Health (FMoH)
2. National Meteorology Agency (NMA)
3. Anti Malaria Association (AMA)
United Nations
4. Environment Program (UNEP)
5. United Nations Children fund (UNICEF)
6. World Health Organization (WHO)
7. Ethiopian Public Health Association (EPHA)
8. Center for National Health Development in Ethiopia (CNHDE)
9. Ethiopian Health and Nutrition Research Institute (EHNRI)
10. School of Public Health
11. Christian Relief and Development Association (CRDA)

Activities

Review the status climate and health information especially on malaria, meningitis and acute watery diarrhea

Review the status of early warning system in the country especially usage of climate information for early epidemic detection and control.

Fostering Research on climate sensitive diseases.

Develop information sharing system

Capacity Building

Accomplishment

"Climate Matters in Health" workshop February 2008

Working Group Meetings

"Science and technical Meeting" Sep 3-5, 2008

MERIT workshop, Dec 1-3

Training

- Ethiopia -
- Kenya -
- Madagascar -

Build appropriate data and information sets.....

Identify user information needs.....

High resolution climatologies

~ Using blended satellite and local data

Develop risks maps, monitoring and modeling products from the above



Train community of practice.



-New York
-Ethiopia
-Kenya
-Madagascar-

..and keep them networked....

Current CIPHA Newsletter: Aug 2009



Spanish

Subsecretaría (Ciencia para la Acción en Salud Pública)

Subsecretaría de Asesoría y Apoyo
CIPHA Chile

NOTICIAS DE NOTICIAS



Este mes de agosto se celebró la 10ª Reunión de la Red de Centros de Investigación y Promoción de la Salud Pública (CIPHA) en Chile. Durante la reunión se abordaron temas como la salud pública, la promoción de la salud, la prevención de enfermedades, la atención primaria de salud, la salud comunitaria y la salud de las mujeres. Se realizaron talleres de trabajo y se presentaron trabajos de investigación. La reunión fue organizada por el Centro de Investigación y Promoción de la Salud Pública (CIPHA) de Chile.

Exposiciones

- 1. Salud Pública y Promoción de la Salud en Chile
- 2. Salud Pública y Promoción de la Salud en el extranjero
- 3. Salud Pública y Promoción de la Salud en el extranjero
- 4. Salud Pública y Promoción de la Salud en el extranjero
- 5. Salud Pública y Promoción de la Salud en el extranjero
- 6. Salud Pública y Promoción de la Salud en el extranjero

[HTML](#) | [PDF](#) (98kb)



Climate Sensitive Disease Learning Resource

USING A SCIENCE-BASED APPROACH TO ENHANCE SOCIETY'S ABILITY TO UNDERSTAND, ANTICIPATE AND MANAGE CLIMATE RISK IN ORDER TO IMPROVE HUMAN WELFARE.

About This Site

Courses and Training Tools

Resources

The IRI is a WHO-PAHO collaborating center for climate-sensitive diseases

Resource Library



Publications



Search by disease

Malaria

Malaria

Meningitis

25 more...

Education



Courses



Training Tools

CIPHA Newsletter



Aut 2009 Information

Climatique Pour la Santé Publique



Agosto 2009 Información

Climática para la acción en Salud

Publica



About Climate Sensitive Disease Learning Resource

The resource has been designed to enable the learner to find out knowledge, methodologies, tools, and data that could be used by the public health community to better manage climate sensitive diseases* to improving health outcomes. It acts as a web portal to guide the learner towards other sources of information. The material is designed in a hierarchic manner, from the simple to the complicated. It makes links with other websites and some published material to give the reader opportunity for further investigation.

This portal is subdivided into four sections: climate sensitive disease net library, courses, training materials and news. The portal is still being developed and the various sections are regularly up-dated.

IRI



PARTNERS

Place holder

Place holder

Place holder

FUNDERS

Place holder

Place holder

The IRI was established as a cooperative agreement between NOAA's Climate Program Office and Columbia University. It is part of The Earth Institute at Columbia University, and is located at the Lamont Campus.



Thank you for your attention

sjconnor@iri.columbia.edu

International Research Institute for Climate & Society (IRI),
The Earth Institute at Columbia University, New York



**PAHO/WHO Collaborating Centre on early warning systems
for malaria and other climate sensitive diseases**

